Holcomb & Kircher

Statistics from Electric Plants of Illinois

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STATISTICS FROM ELECTRIC PLANTS OF ILLINOIS

BY

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THESIS

FOR THE

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IN

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IN THE

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THIS IS TO CERTIFY THAT THE THESIS PREPARED UNDER MY SUPERVISION BY

CLARENCE EUGENE HOLCOMB and HARRY BERTRAM KIRCHER

ENTITLED STATISTICS FROM ELECTRIC PLANTS OF ILLINOIS

IS APPROVED BY ME AS FULFILLING THIS PART OF THE REQUIREMENTS FOR THE DEGREE

OF Bachelor of Science in Electrical Engineering.

Morgan Brooks

HEAD OF DEPARTMENT OF Electrical Engineering.

STATISTICS FROM ELECTRIC PLANTS OF ILLINOIS

The purpose of this thesis was to collect data concerning the electric light plants of the State of Illinois outside of the city of Chicago. An effort was made to secure data from all towns of over five thousand inhabitants. In order to get the data in suitable shape a printed form was gotten out containing the list of questions which it was thought desirable to have answered. One of these printed forms was sent to each superintendent in the sixty-five towns investigated. Each blank was accompanied by a letter explaining the purpose of the blank and special attention was called to the questions concerning the combination of electric light plants with central heating stations.

Out of a total of sixty-five letters sent out forty-four replies were received. It proved in most cases to be a difficult matter to secure information from the superintendents as it was necessary to write them several times. Even then twenty-one were never heard from. Out of the forty-four replies received six were found of little use. Of the remaining thirty-eight there were fourteen plants run by steam for electrical output only, and five were mainly driven by water power. Of the thirty-eight, six were municipal plants.

The data is arranged in tables so as to show the results as clearly as possible and for obvious reasons the names of the plants are omitted, numbers being substituted for the names. Since

the data was secured with the intention of finding out something definite concerning district heating, particular attention will be given to this subject after considering the question as a whole.

The subject will first be treated as a question of investment per capita. Summing up the totals of population and investment in the cities having electric light plants it is seen that for a population of three hundred and nineteen thousand there is $7,991,000 of stock and $6,305,000 in bonds making a total investment of $14,296,000. This shows an investment of $25,050 in stock and $19,760 in bonds per thousand of population or a total of $44,810 per thousand. Classifying the cities according to size we have seventeen having a population between five and ten thousand, four between ten and fifteen thousand, five between fifteen and twenty thousand, one between twenty and twenty-five thousand, and one between fifty and sixty thousand. The following table shows the investment in stocks and bonds per thousand of population in each class of towns.

Size of Cities	Stock per 1000 People	Bonds per 1000 People
5,000 - 10,000	18,800	11,900
10,000 - 15,000	12,710	12,800
15,000 - 20,000	28,910	23,620
20,000 - 25,000	19,050	19,050
50,000 - 60,000	43,860	35,080

The investment per thousand of population is seen to be larger in the larger towns than in the small ones. This is due to the fact that the number of customers for a public utility plant is greater in proportion to the population in the larger than in the

smaller towns.

The price paid for coal by the different plants varied greatly: the range being from fifty cents to three dollars per ton. The reason for this great difference in the price of coal can be traced to location and quantity used per year. All of the coal was Illinois coal with but a single exception.

From the data secured in regard to heating plants it seems that they are not considered a very profitable investment. To run a heating plant in connection with an electric light plant it is necessary to use exhaust steam to furnish the heat. The steam may be use directly or as a means of heating water for a hot water system. To be profitable the heating plant income must be sufficient to pay for depreciation on the system interest on the investment and make up for the loss occasioned by not being able to make use of the exhaust steam during the summer time. We find however that two of the plants #8 and #11 run condensing when not using their steam for heating purposes. Though most towns having heating plants do not consider them very good investments, yet those not having them explain it by saying that they are too for form the district to be heated. It is essential that the heating plant should be near the center of distribution.

The employment of extra men can in most cases be avoided. Companies finding it necessary at times to run their boilers for furnishing heat to customers are as a rule dissatisfied with their investment, while those who do not accept more heating business than their exhaust steam supply can handle are satisfied. It is difficult to obtain definite data on the profits made on either the heating of the light plants as in most cases the books are kept together

and it is difficult to separate the accounts. Those companies having a railway or motor load do not find it necessary to run boilers for heating but where there is only a lighting load the peaks come at different times of the day. The greatest requirement for heat is in the morning while that for light naturally comes in the evening. It is noticeable that the heaviest demand for power and the heaviest demand for heat never come at the same time. The repair bill seems to be a very small item and the depreciation should not exceed five per cent.

Of a total of fourteen plants four used a hot water system, the remaining ten using exhaust steat direct. The only reason for this seems to be that the steam system is more cheaply installed, as it is generally supposed that the hot water is the better system.

As a summary of these investigations, we conclude that:

A heating plant in connection with an electric plant is profitable under the following conditions: (a)Central location which makes the distributing mains short and consequently the initial cost low and the loss from radiation small. (b) Sufficient patronage to warrant the installation though keeping within the limit of the exhaust steam. (c) Uniform electric load so that there is a supply of exhaust steam throughout the day. An electric road fulfills this condition as one of its peaks comes at the same time as the peak of the heating load.

POPULATION, KIND OF PLANT, CAPITALIZATION.

No.	Population	Municipal?	Capital Stock	Bond Issue
1	15,000	No	$650,000	$650,000
2	10,000	No	100,000	100,000
3	6,000	No	180,000	140,000
4	5,000	No	- - - -	- - - -
5	17,000	No	700,000	650,000
6	21,000	No	400,000	400,000
7	6,000	No	200,000	175,000
8	6,000	No	200,000	125,000
9	8,000	No	- - - -	- - - -
10	9,000	No	200,000	200,000
11	57,000	No	2,500,000	2,000,000
12	5,000	No	140,000	125,000
13	10,000	No	150,000	125,000
14	6,000	No	100,000	56,000
15	5,000	No	20,000	- - - -
16	18,000	No	350,000	290,000
17	4,000	Yes	- - - -	- - - -
18	7,000	No	50,000	0
19	7,000	No	150,000	110,000
20	5,000	No	30,000	15,000
21	23,000	Yes	- - - -	- - - -
22	5,000	Yes	0	0
23	6,000	No	- - - -	- - - -
24	9,000	No	255,000	15,000
25	6,000	No	50,000	50,000

No.	Population	Kind of Plant Municipal?	Capitalization	
			Capital Stock	Bond Issue
26	5,000	Yes	0	30,000
27	5,000	No	23,500	0
28	7,000	No	160,000	150,000
29	5,000	No	28,000	0
30	6,000	Yes	- - - -	15,000
31	7,000	Yes	0	- - - -
32	7,000	No	45,000	10,000
33	15,000	No	100,000	60,000
34	8,000	No	100,000	50,000
35	14,000	No	350,000	255,000
36	14,000	No	10,000	125,000
37	18,000	No	600,000	300,000
38	7,000	No	250,000	125,000

STOCKS AND BONDS

Towns of from five thousand to ten thousand.

No.	Population	Stocks	Bonds	Stock per M	Bonds per M
3	6,000	$180,000	$140,000	$30,000	$23,300
7	6,000	200,000	175,000	33,300	29,200
8	6,000	200,000	125,000	33,300	20,800
10	9,000	200,000	200,000	22,200	22,200
12	5,000	140,000	125,000	28,000	25,000
14	6,000	100,000	56,000	16,600	9,300
15	5,000	20,000	0	4,000	0
18	7,000	50,000	0	7,100	0
19	7,000	150,000	110,000	21,400	15,700
20	5,000	30,000	15,000	6,000	3,000
24	9,000	255,000	75,000	28,300	8,300
25	6,000	50,000	50,000	8,300	8,300
27	5,000	23,500	0	4,700	0
28	7,000	160,000	150,000	22,800	21,400
29	5,000	28,000	0	5,600	0
32	7,000	45,000	10,000	6,400	1,400
34	8,000	100,000	50,000	12,500	6,200
38	7,000	250,000	125,000	35,700	17,800
Tot'l	116,000	2,181,500	1,406,000	18,800	11,900

Towns of from ten to fifteen thousand.

No.	Population	Stocks	Bonds	Stock per M	Bonds per M
2	10,000	$100,000	$100,000	$10,000	$10,000
13	10,000	150,000	125,000	15,000	12,500
35	14,000	350,000	255,000	25,000	18,200
36	14,000	10,000	125,000	700	8,900
Total	48,000	610,000	605,000	12,700	12,800

Towns of from fifteen to twenty thousand.

1	15,000	650,000	650,000	43,300	43,300
5	17,000	700,000	650,000	41,200	38,200
16	18,000	350,000	290,000	19,400	16,100
33	15,000	100,000	60,000	6,600	4,000
37	18,000	600,000	300,000	33,300	16,600
Total	83,000	2,400,000	1,950,000	28,900	23,600

Towns of from twenty to twenty-five thousand.

6	21,000	400,000	400,000	19,050	19,050

Towns of from fifty to sixty thousand.

11	57,000	2,500,000	2,000,000	43,800	35,100

CAPACITY OF PLANT AND KIND OF LOAD

No.	BHP Rated	BHP actually used	Generator KW	% Each kind of Load
1	1,500	1,500	1,350	40% Ltg., 10% Mot., 50% Ry.
2	23,000	2,000	1,350	Ltg., Mot., Ry.
3	390	390	- - -	60% Ltg., 40% Motor
4	400	400	335	Ltg.
5	3,450	3,000	1,750	Ltg., Motor, Ry.
6	1,200	1,000	750	Ltg., Motor
7	500	700	850	Ltg., Motor, Ry.
8	360	260	190	Ltg.
9	2,500	2,200	900	Ltg., Motor
10	750	400	375	95% Ltg., 5% Motor
11	2,400	2,400	3,000	72% Ltg., 28% Motor
12	500	800	400	Ltg , Motor
13	1,400	1,400	180	Ltg
14	450	450	320	90% Ltg , 10% Motor
15	300	200	195	Ltg.
16	700	450	525	Ltg., Motor
17	150	120	60	Ltg.
18	240	240	185	Ltg.
19	500	350	300	8% Ltg., 92% Motor
20	300	230	210	Ltg.
21	500	350	370	Ltg.
22	125	80	60	Ltg.

No.	BHP Rated	BHP actually used	Generator KW	% Each kind of Load
23	450	300	200	Ltg.
24	375	250	- - -	Ltg.
25	150	150	100	Ltg.
26	125	125	- - -	Ltg.
27	225	150	175	Ltg.
28	270	220	- - -	Ltg.
29	500	300	200	80% Ltg., 20% Motor
30	400	200	56	Ltg.
31	275	200	200	80% Ltg., 20% Motor
32	300	200	200	Ltg.,
33	400	350	375	85% Ltg., 15% Motor
34	400	- -	265	30% Ltg., 70% Motor
35	750	350	1,100	66% Ltg. and Motor, 34% Ry.
36	600	600	1,060	60% Ltg., 40% Motor
37	3,500	3,000	7,500	30% Ltg., 30% Motor, 40% Ry.
38	380	280	300	80% Ltg., 20% Motor

COAL AND WATER

No.	Kind of Coal Used	Cost per Ton	Tons per Year	Source of Water	Cost per M Gal.
1	Nut, Pea, Slack	$1.00	15,000	City	$0.06
2	Scrgs. and Mine-run	1.00-2.00	20,000	Deep well	- -
3	Slack, Nut & Pea	1.35	7,000 to 8,000	City	200.00
4	Mine-run	1.69	4,600	City	.08
5	Ill. Bit.	1.10	50,000	City	.06
6	Ill. Bit	1.15	12,000	City	.06
7	Ill. & Ind. Scrg. & Lmp.	1.90-2.60	8,000	City	- -
8	Pea & Slack	1.00	3,600	- - -	- -
9	Ill. Scrg & Nut	2.00	16,000	Deep well	- -
10	Mine-run & Scrg	.91½ to 1.31½	- - -	City	Flat rate.
11	Scrg. & Mine-run	1.00-1.60	25,000	Ill.River	- -
12	Sp'gf'd & Pont.Scrg.	1.51-1.85	- - -	Vm.River	- -
13	Scrgs.	2.20	- - -	Art.Well	- -
14	Scrgs.	1.75	1,800	Ill. River	.12
15	Scrgs.	1.00-2.25	5,500	City	.10
16	Ill. Mine-run	1.39	6,500	Deep well	- -
17	Scrgs.	1.60	100	Deep well	- -
18	Mine-run	1.625	2,350	Well and Creek	- -
19	Local	.50	3,000	City	.09
20	Nut, pea and Slack	1.15	3,200	City	.20
21	Wil. Ill. Lump	2.60	3,500	City & River	- -
22	Winona St'm Lump	- -	- - -	Well	- -
23	Cart.vl. 2½"Scrugs	1.85	3,650	Art. Well	.04

No.	Kind of Coal Used	Cost per Ton	Tons per Year	Source of Water	Cost per M Gal.
24	Mine-run Slack	$1.85-1.35	4,500	Well	- -
25	Slack	1.00-1.15	1,800	City	$4.20
26	Nut and Scrgs	1.60	1,825	River	- -
27	Ill. Bit.	2.70	1,200	Canal	- -
28	Scrgs.	1.25	3,600	River	- -
29	Nut and Pea	1.30	3,600	River	- -
30	S. Ind	2.50	1,800	Res.	- -
31	Peru Scrgs	1.40	4,700	- - -	- -
32	Scrgs	1.50	2,560	- - -	.08 to .10
33	Ill. Wshd Scg.	1.30	5,000	Wells & Co.	.20
34	Std Lump	3.00	- - -	River	- -
35	Ill. Lump	2.60	3,000	City	.08
36	M R	2.40	2,000	River	- -
37	Slack	1.70-2.30	18,000	River	- -
38	Slack	1.80	400	River	- -

Answers to the question: "Did you ever figure on installing a heating plant? Reasons for not installing"

15	Yes	Did not consider that it would be a good investment.
16	No	
17	No	No capital for such a purpose.
18	No	Too far from district to be heated.
19	No	
20	Yes	Lack of capital and franchise.
21	No	
22	No	
23	Yes	Too expensive on account of great distance.
24	No	Plant is too far from town.
25	No	
26	- -	
27	No	Town is distributed over too large an area.
28	No	
29	No	
30	No	Too far from city.
31	No	
32	Yes	Lack of capital.
33	Yes	Could not get enough consumers. Coal is cheap and not enough people would go to the expense of putting in pipes or paying for heat. Large portion of people are coal miners. Made canvass for steam also hot water. Became satisfied could not be made to pay interest on investment.
34	No	We use water power.

35	No	We use water power and condensing engines.
36	No	Not enough exhaust steam.
37	No	Too far from business districts.
38	No	No money in it. Maintenance too high. We run with water power.

COST, COMPANY INSTALLING AND KIND OF SYSTEM

No.	How long has Heating Plant been in?	Cost	Company Installing	Steam or Hot Water
1	Four years	$40,000	Ourselves	Water
2	Three "	70,000	A. D. S. Co.	Steam
3	Three "	15,000	Pierce Co.	Steam
4	Two "	8,000	A. D. S. Co.	Steam
5	Eight "	90,000	A. D. S. Co.	Steam
6	One Year	75,000	A. D. S. Co.	Steam
7	Eight years	- - -	A. D. S. Co.	Steam
8	Two " (Combination with Light)		Schott Bal. Cal. System	Water
9	Three "	- - -	Ourselves	Water
10	One year	- - -	A. D. S. Co.	Water
11	Two years	- - -	A. D. S. Co	Steam
12	Three "	35,000	A. D. S. Co.	Steam
13	Three "	- - -	A. D. S. Co.	Water
14	Three "	11,000	A. D. S. Co.	Steam

HOT WATER PLANTS

No.	How water is heated	Temperature Outgoing	Return	End line	Size tank
1	Exhaust steam	180-190°	150-160°	175-184°	No tank
8	Exhaust steam and by circulating through boiler.	200°	170	196	Small
9	Exhaust steam and boiler.	Depends on outside temperature			600bbls
13	Exhaust, live and boilers	"	"	"	No tank

STEAM PLANTS

No.	Live or exhaust	Pressure
2	Both	3 - 15#
3	Both	6#sta. 2# to customer
4	Both	5# cold weather
5	Both	3 - 15#
6	Both	5
7	Both	3 - 4
10	Both	5 - 8
11	Both	3 - 5
12	Both	3 - 8
14	Both	½ - 3

DISTANCE FROM BUSINESS PORTION. MAINS AND EXTRA MEN

No.	Distance from Business portion	Size of Mains	How protected	Extra Men
1	Located at center	6"	Mykoff and Board covering	1
2	2500 feet	10"	A. D. S. Co. log	1
3	2500 "	8"	None	2
4	800 "	8"	Asbestos & tin-lined wood	1
5	200 "	12"	4" shell wood log	-
6	3000 "	14"	Wood log	L
7	300 "	10"	Wood log	1
8	1300 "	8"	Improved Yaryan Insulation	2
9	800 "	10"	Boxed in with wood shavings	-
10	Center of City	10"	Wood log	0
11	1000 "	18"	Brick conduit and covering on wood log	-
12	1500 "	10"	Wood log	0
13	300 "	10"	Yaryan Insulation	-
14	900 "	8"	Wood log	0

PEAKS OF LOADS AND BUILDINGS HEATED

No.	Heaviest Demand for Power	Heaviest Demand for Heat	No. Buildings Heated	Cubic feet Heated	Do you ever run boilers for heating Purposes only?
1	5 - 10 P.M.	- - - - -	100		No
2	4 - 9 "	6 - 12 AM	110		Yes
3	4:30-6:30 "	Uniform	45		No
4	- - - - - -	- - - - -	65	1,569,300	Yes
5	4 - 6 "	6 - 7 AM	375	15,000,000	Yes
6	- - - - - -	6 - 7 AM	25		Yes
7	4 - 6 "	6 - 12 "	- -		No
8	6 - 8 "	- - - - -	51	Sq.Ft. Rad. 30,000	Yes
9	4:30-11:00 "	- - - - -	600		Yes, $\frac{1}{2}$ time
10	5 - 9 "	6 - 11 AM	20		No
11	Irregular	Irregular	59	82,000	No
12	- - - - - -	5 - 9 AM	- -		No
13	5 - 10 "	- - - - -	- -		Yes
14	6 - 11 "	5 - 9 AM	28	Cubic Feet 20,000	Yes

CHARGE FOR HEAT. REPAIR BILL

No.	Charge for Heat	Run condensing in Summer	Repair bill per year
1	12½¢ per Sq. Ft. Radiation	No	$1000=2½%
2	$2.50-3.50 per 1000 Cu. Ft.	No	- - - - -
3	- - - - - - -	No	- - - - -
4	3.00-3.75 per 1000 Cu.Ft.	No	None,so far
5	25¢ per Sq. Ft. Radiation	No	Practically 0
6	25¢ per " " "	No	None
7	35¢ per " " "	No	$500.
8	12½¢ " " " "	Yes	Practically 0
9	- - - - - - -	No	- - - - -
10	Flat rate or meter	No	- - - - -
11	25-40¢per Sq. Ft. Radiation. 50¢ per 1000# cond.	Yes	- - - - -
12	20¢ per Sq. Ft. Radiation	No	- - - - -
13	20¢ " " " "	No	- - - - -
14	25¢ " " " "	No	0

The following answers were received to the questions; Is your heating system a profitable investment? What per cent does it pay?

1. It depends on depreciation. We will not go above our exhaust steam capacity. We believe that the depreciation on the plant will make it unprofitable.

2. No. Does not pay anything.

3. With exhaust, yes; live steam, no. (b) Nothing.

4. Yes. Can not tell what per cent on account of not being able to determine exactly what proportion of coal is used for lighting.

5. We think so. This could only be answered conditionally. If we compare it to a plant operated compound condensing perhaps profit obtained as compared to profit obtained by putting the 90,000 in more efficient apparatus would be very small.

6. We don't know as yet.

7. Yes we think so. (b) Ask something easy.

8. Yes. Light and heat together pay about 10%.

9. - - - - - -

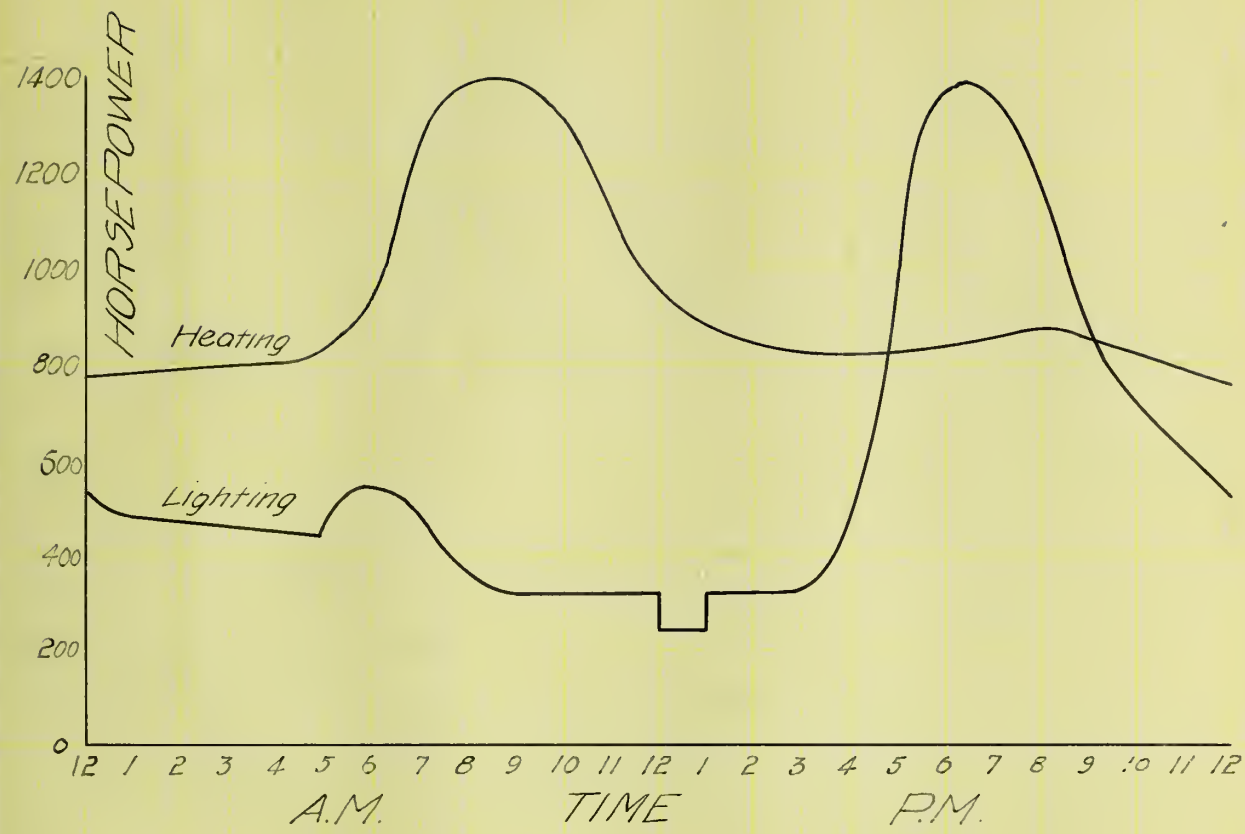
10. Do not know as yet.

11. Reasonably profitable.

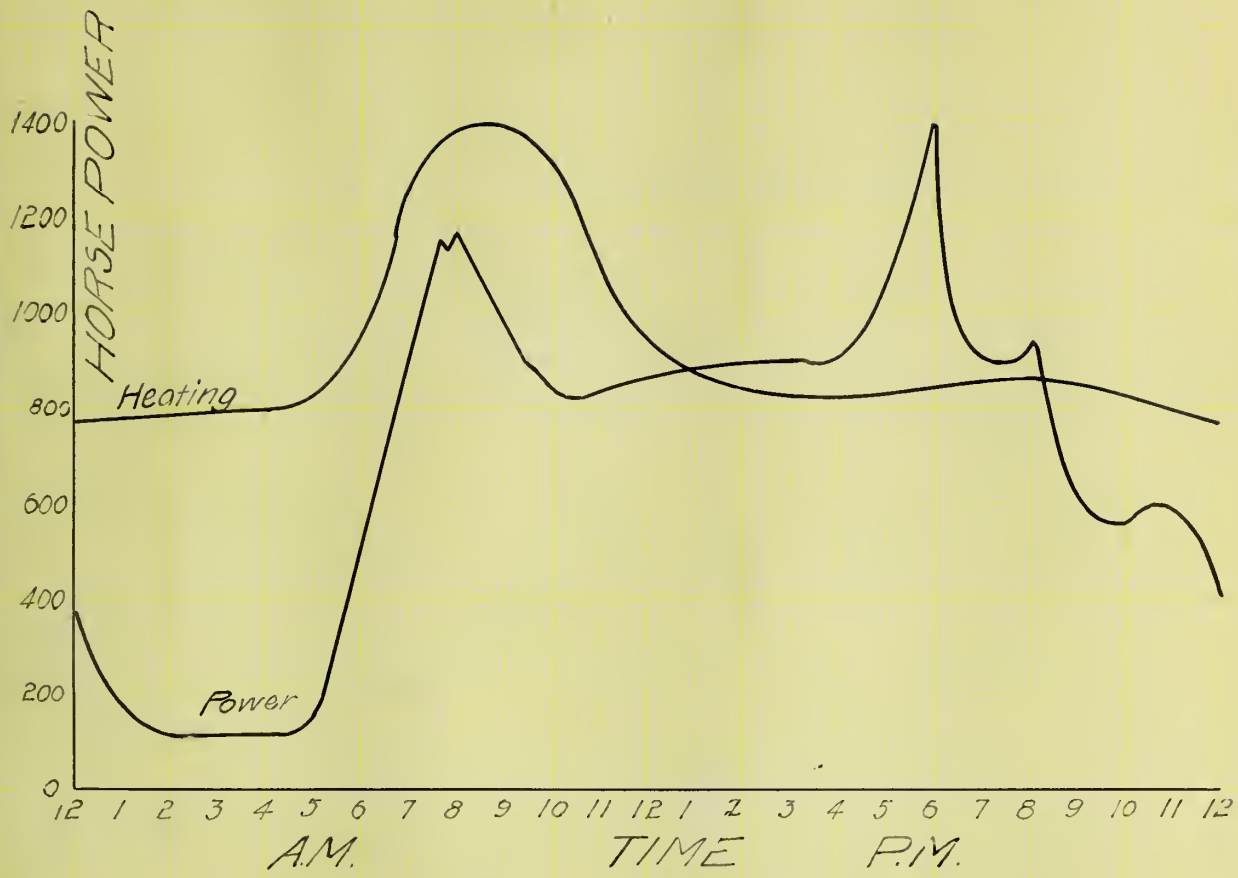
12. It would be impossible to give very accurate data owing to accounts not being carried separately.

13. No

14. When run in connection with an electric plant, yes; though a heating system pays very little on the investment.



Hourly heat demand, compared with the output of an average electric lighting station. Both reduced to boiler horse power.



Hourly heat demand, compared with the output of an average electric railway station. Both reduced to boiler horse power.

HOLCOMB & KIRCHER—THESIS

City Number Eight.

Is yours a Municipal plant? No

What is your capital stock? $200,000.

What is your bond issue? $125,000

Size of plant.

Boiler H. P. (Maximum? 360

(Actually used? 260

Generator H. P.? 250

Is load lighting, motor, street railway or what combination? Lighting.

Give % of each kind of load.

Heaviest demand for power. (Time? Six to eight P.M.

(Extent?

Distance of plant from business portion of city? One-fourth mile

What coal do you use? Pea and Slack

What does it cost you per ton? $1.00

How many tons do you use per year? 3600 tons

How many tons from October 1 to April 1?

Source of water supply? Reservoir We operate the water works.

If bought from the water company what is the rate?

Do you run a central heating station in connection with your power plant? Yes

If not, did you ever figure on installing one?

Reasons for not installing?

How long has your heating plant been in? The past winter is our second winter.

What did it cost? It was put in in combination with the light plant.

What company installed it? Schott's Balanced Column System.

Do you use steam or hot water for heating? Hot water

If steam { Live? ..... Exhaust? ..... Both? .....

What pressure do you use? .....

If water.

How do you heat the water? With exhaust steam and by circulating through a boiler.

Temperature of outgoing water at station? 200° at Zero weather.

" " returning " " " ? 170 " " "

" " water at end of pipe line ? 196 " " "

What size storage tank do you have? We do not use a storage tank except a small one for our boiler.

Size of mains? Eight inch

How are they protected? By Improved Yaryan Insulation.

Do you ever run boilers for heating purposes only? Yes

If so, how much of the time? With our present load we run one 80 HP all the time.

What is the heating system repair bill per year? We have had practically nothing so far.

How many extra men does the heating system require? Two.

Heaviest daily heat demand (Time? According to weather.

(Extent? .....

Do you run condensing when heating load is light? Yes

Number of buildings heated? Fifty-one

Cubic feet heated? We have connected 30,000 Sq. feet of Radiation.

Ratio of heating surface to cu. ft. heated? .....

What do you charge for heat? 12½¢ per Sq. Ft. of Radiation per year.

Is your heating system a profitable investment? Yes

What % does it pay? Light and heat together pay about ten per cent.

REMARKS: (Any enlargement on the above will be appreciated.)

The cubic foot basis of figuring radiation is becoming obsolete. Heat should be sold according to the amount of radiation required.